MUSKWA PROJECT WORKING PLAN

Ministry of Environment
Fish and Wildlife Branch
Fort St. John, B.C.

Wildlife Working Report No. WR-7
December 1984

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by

J. P. Elliott

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SUMMARY

This report outlines the goals and objectives of the wildlife program with special emphasis on Stone's sheep, elk, caribou and moose in the Muskwa Project Area (19 000 sq km - 7336 sq mi) of northeast British Columbia. Described are the study area and the population status of those species present, in comparison to their past and future potential. Reference is given to the range enhancement that has been undertaken to augment those populations and the supply and demand for those species. Major declines in numbers of the four large mammal species from past levels are documented and excessively high mortality of animals prior to breeding age is identified as a major cause of the declines and as a limit to recovery. Much of this mortality appears to result from predation by wolves which occur in the area at a very high density. A program of wolf management is proposed to reduce the mortality of young sheep, elk, caribou, and moose to allow those populations to increase and take advantage of vacant or underutilized range and the range enhancement that has been done. Monitoring and review are an integral part of the program.

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BACKGROUND

The goal of the Muskwa project is to reverse the decline in ungulate (Stone's sheep, elk, caribou and moose) populations and provide additional hunting and non-hunting recreational opportunity by maintaining a balance between wolves and ungulates. Work in other areas has shown that in many cases control of predator populations has resulted in an increase in ungulates.

Habitat enhancement activity, chiefly controlled burning, has been conducted in this area and the forage has been increased for elk and sheep but, because of high mortality, the elk and sheep populations have not increased even though there is an abundance of food and favourable habitat.

Hunting of the four ungulate species in the Muskwa is currently limited to the taking of males and has not contributed to the decline of the basic breeding herds.

The project will run for a three year period from 1984 to 1987. If a statistically significant improvement in ungulate recruitment and survival can not be demonstrated, the wolf reduction will cease. If there is a statistically significant improvement in ungulate recruitment, the program will be fully evaluated for future direction.

Some of the reasons for selecting the Muskwa for wolf management were:

1. A high wolf population was recorded in the area.
2. There is a diverse population of ungulates.
3. There is evidence that wolf predation is a principal factor in reducing ungulates in the area.

There is considerable potential in the area to supply additional hunting to replace hunting opportunities which are being reduced in other areas.

OBJECTIVES

Specific work objectives of the project are:

1. to estimate annually the late winter wolf pack size and density of wolves;

2. to reduce wolf densities to 1 wolf/260-390 km^2 (100 - 150 mi^2) within the project term and to maintain wolf densities not greater than 1 wolf/155km^2 (60 mi^2)in the long term;

3. to estimate the densities of elk, moose, and Stone sheep in representative subunits at the beginning and the end of the project;

4. to determine the proportions of moose and elk aged 6,10,18,and 22 months of age relative to adult cows(>22 months).

5. to determine the proportion of sheep aged 10 and 22 months relative to adult ewes (>22 months);

6. to determine the proportion of caribou calves in caribou herds during the fall rut period;

7. to increase the population of elk over a five year period from 4300 to 10 000; Stone sheep from 3500 to 5000; moose from 18 000 to 27 000; caribou from 950 to 1800.

8. to maintain the population of elk over a ten year period at 20 000; Stone sheep at 6000; moose at 30 000 and caribou at 2000.

The Muskwa Project must be considered within the context of zonal and provincial management objectives and priorities. This allows definition of the relative importance of the Muskwa Project Area from a management and budgeting perspective.

Table 1 presents the provincial concept of species priority (Fish and Wildlife Branch 1979). Those priorities were derived from the published goals and objectives of wildlife management, an appreciation of public demand, and the need for public safety at the provincial level. The goal of wildlife management for the province is to:

maintain the diversity of species representative of the major biophysical zones of the province;

ensure that within constraints of land capability and biophysical limits of each species, wildlife is available in sufficient abundance to meet the recreational and economical needs of society.

Table 2 presents the proposed provincial objectives (Fish and Wildlife Branch 1979) for the first three species priorities at the provincial level and those for the wolf (priority three). (As shall be seen, there are some inconsistencies between these objectives and those of the zone which result from the accrual of new information since the provincial objectives were defined in 1978).

The northeast zone (Figure 1), as the name implies, lies in the northeast corner of British Columbia. It comprises approximately 14% of the land area of the province.

Due to the large size and ecological diversity of this zone, it has been subdivided into smaller units suitable for project planning. Those eleven units are shown in Figure 2. Boundaries were chosen on the basis of wildlife

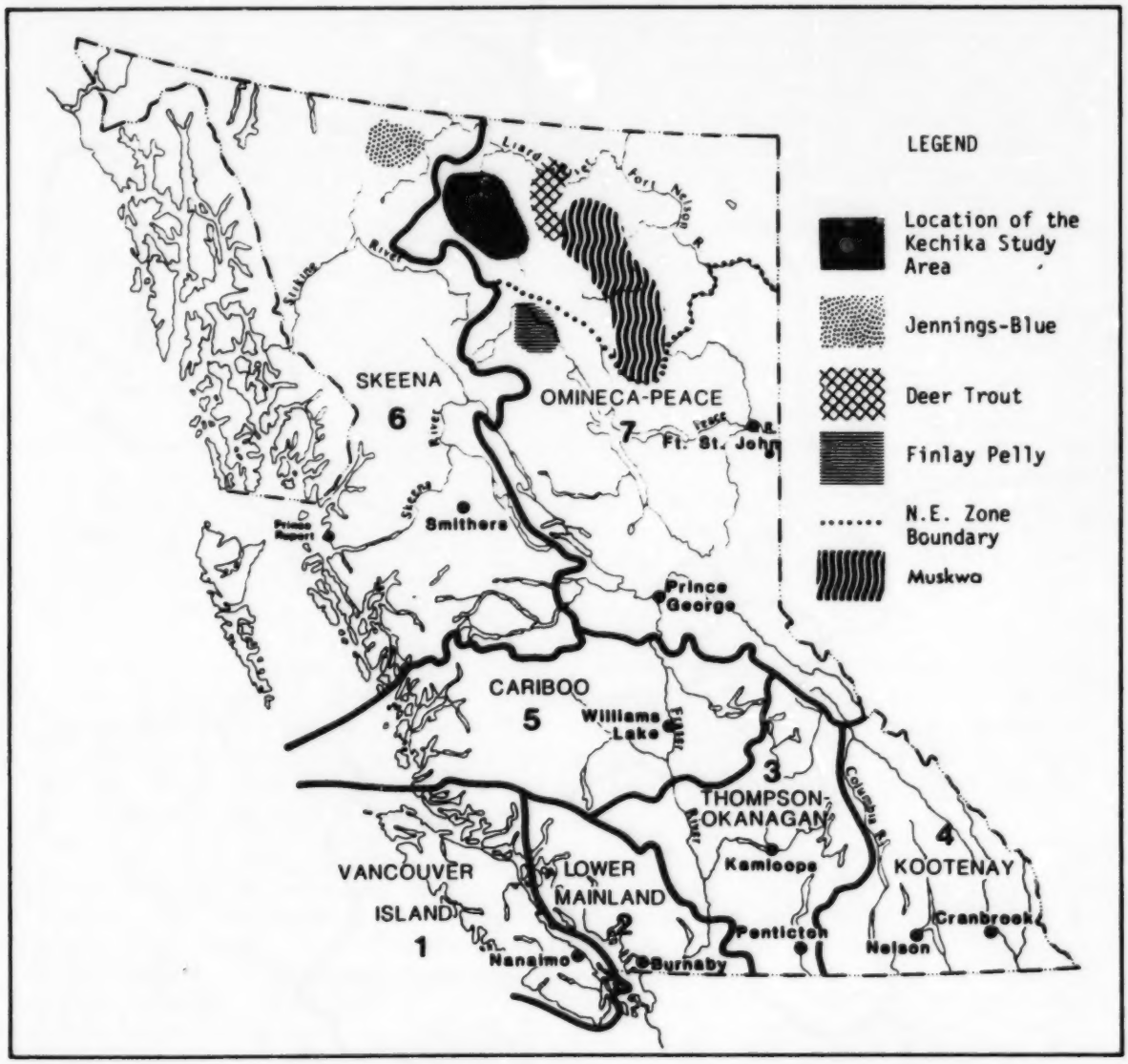

Figure 1. Map of British Columbia showing the location of areas referred to in the text and the zonal NE administration boundary.

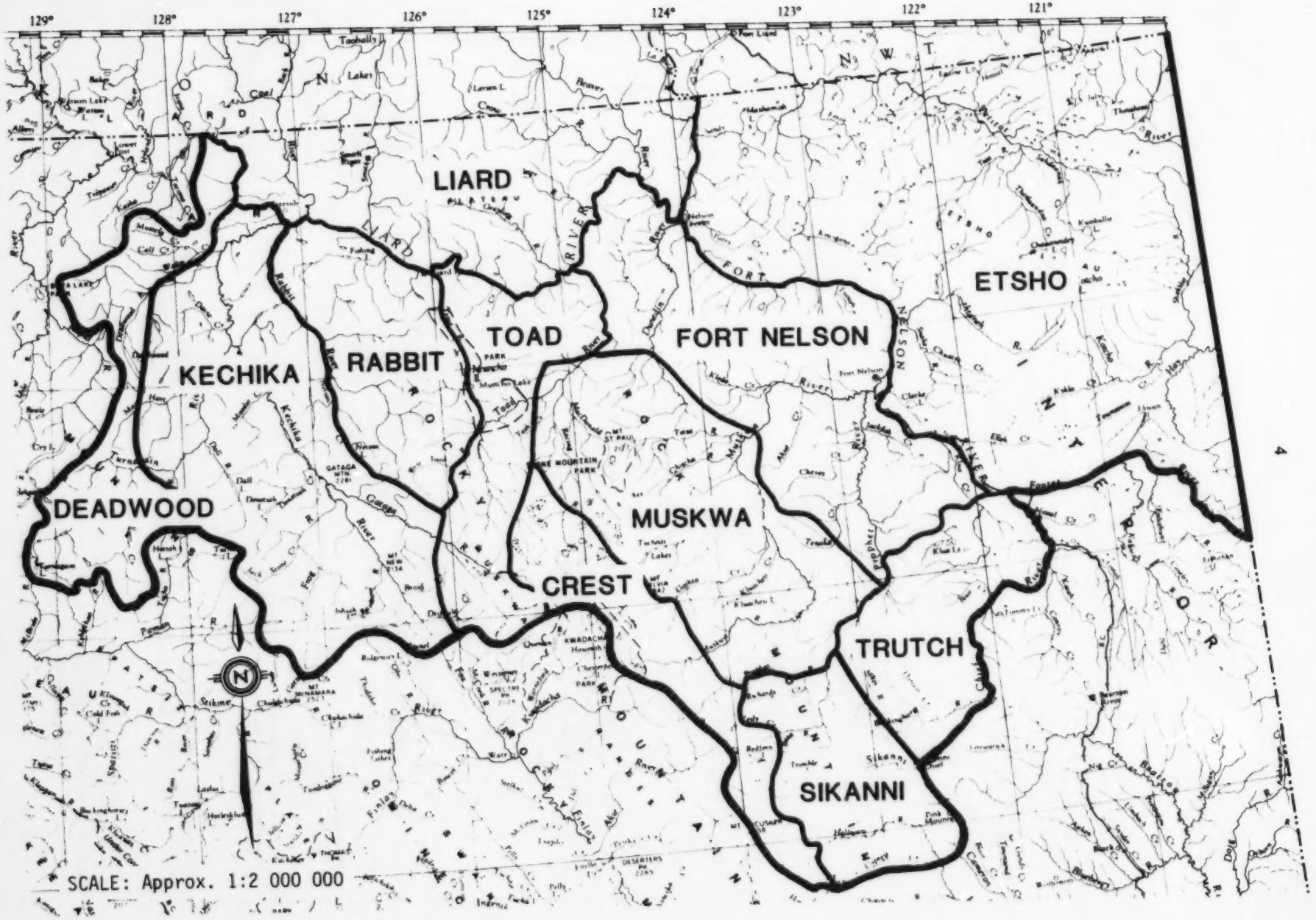

FIGURE 2: Subunits of the north east zone.

use, public use, existing administrative boundaries, and major land features. Those boundaries may be refined in the future. Table 3 gives the approximate land areas of those units.

Zonal species priorities (Table 4) have been defined, paralleling the provincial scheme. These priorities were defined on the basis of numerical abundance, potential for increase through management, and perception of public interest/demand. Elk, Stone's sheep, and moose are given the highest rating. Elk have a high demand by the public and a tremendous potential for expansion in this zone. Stone's sheep have the highest demand from the trophy standpoint and the northeast zone is the major Stone's sheep area in the province. Moose is the most abundant ungulate in the zone, and provides the largest component of the ungulate biomass. The full value of the zonal moose and wolf potential may not be fully useable because of the remoteness of portions of the area.

Table 5 outlines population sizes for the zonal first priority species plus caribou. Caribou are included in the table to reflect the higher ranking in provincial priorities (Table 1).

Table 6 provides the zonal objectives for these same species. A comparison of this information to that of Table 2 shows that the zone can supply 113% of the province's elk objective, 112% of that for Stone's sheep, 33% of that for moose, and 30% of that for caribou and maintain wolves in balance with the ungulates. As noted already, some of the provincial objectives are no longer valid with 50 000 elk and 25 000 Stone's sheep probably being more realistic. This would lower the zone contribution to the total of 50% for elk and 72% for Stone's sheep.

Unlike the objectives for Stone's sheep, moose, and caribou, the elk objective exceeds recent historical population levels. Given the substantial increase in elk during the low wolf era and the ongoing range expansion program, potential for substantial increase is felt to exist. A precise optimal level cannot be determined at this stage although it is apparent that it is well above present numbers.

Table 7 examines the contribution on a percentage basis that each of the subunits can make towards meeting the zonal objective. Table 8 takes these numbers, divides them by the subunit land area and multiplies by 100 000 in order to derive an area-free rating which can be used in subunit priorization. The final ranking is somewhat arbitrary. Elk and Stone's sheep from this zone must be given a greater weighting than moose (the other first priority species of Table 4) to meet the provincial objectives. While moose and caribou are rated equally provincially, the smaller potential for caribou dropped it one level zonally (Table 4). Elk and Stone's sheep, therefore, will be weighted 1.00; moose, 0.50; and caribou 0.25.

Table 9 takes the ratings of Table 8, weights them, and yields an overall zonal rating and priority rank. It can be seen that the Muskwa unit is the most important in meeting zonal objectives with the Kechika and Sikanni units the next most important. The Muskwa unit alone can provide 24% of the province's elk objective, 24% of the province's Stone's sheep objective, 7% of the province's moose objective, and 5% of the province's caribou objective and the balance as required to meet the provincial wolf objectives.

PURPOSE

It was highlighted in the first section that the Muskwa subunit was the priority subunit to meet the zonal wildlife management objectives. It can, however, be seen that the present numbers of animals in that area are below the objectives. Unfortunately existing numbers of animals do not present the full picture. The viability of the herds is poor.

Currently both Stone's sheep and caribou are being fully utilized by resident and non-resident hunters. Because of declining populations the hunting of the four ungulate species has been limited to adult males only.

Stone's sheep are in the worst position with major declines having occurred. Each year's delay in Stone's sheep management requires a minimum of one year just to regain the loss. Thus there are two years lost for every year delay before any improvement is gained on present numbers.

The situation for elk is less urgent than that for Stone's sheep but is still serious. A major thrust has been made to expand the elk herd within the zone. It has thus far been two-pronged: 1) range expansion through controlled burning, and 2) supplementary introductions (planned). These programs are, however, dependent upon a vigorous (expanding) Muskwa herd as elk will be reluctant to establish on new ranges if population pressure is lessening on traditional ranges through herd decline. In addition, a declining herd provides little surplus for hunting.

Moose problems are ameliorated by a lower level of demand at this time with no enhancement programs dependent on a vigorous population nor extreme hunting pressure. However, the supply of moose is rapidly declining.

Caribou do not seem to be further declining but are present at only about one-third of past recorded levels for the unit with little available for hunting. Sport hunting of wolves is low yet wolves are clearly implicated as the primary cause for the decline in numbers of ungulates. A reduction in wolf numbers is required.

STUDY AREA

GENERAL

The study area lies southwest of Fort Nelson, British Columbia (Fig. 3) and encompasses portions of the Eastern System of the Canadian Cordillera and the Interior Plains (Holland 1964). The physiographic zones involved are the Muskwa Ranges of the Rocky Mountains, the Rocky Mountain Foothills, a fringing cuesta, and the Fort Nelson Lowlands of the Alberta Plateau to the east. Extending from Cypress Creek in the south, to the Toad River in the north, the area covers approximately 19 000 km .

THE ROCKY MOUNTAINS

The Muskwa Ranges

Characteristic of the Muskwa Ranges and the Rocky Mountain Foothills to the east are the uneven glaciation and the extensive valleys eroded parallel to structural trends of faulting, or belts of easily eroded rocks. The result is a pronounced trellis pattern, with deeply eroded valleys such as the Prophet, Muskwa, Racing, and Churchill Rivers. These and other rivers rise abruptly in steep relief from the Boreal White and Black Spruce to the Spruce-Willow-Birch and extensive Alpine Tundra Biogeoclimatic Zones (Krajina 1965).

Within the study area, the Muskwa Ranges are deeply eroded in Devonian and Permo-Carboniferous limestones which were largely covered during the Pleistocene by continental ice to elevations between 1200 and 2400 m. Many areas have elevations higher than this, with peaks such as Mount Churchill rising to 3200 m. These are highly castellated quartzite and limestone ranges which, combined with the effects of the alpine and valley glaciation and lengthy valleys created by ice retreat, offer spectacular scenery and a diversity of wildlife habitats.

THE ROCKY MOUNTAIN FOOTHILLS

Within the Rocky Mountain Foothills, there are two subdivisions of inner and outer foothills which run parallel to one another in a northwesterly direction. The inner foothills abut against the Rocky Mountains on the west, and consist of closely folded fault zones of thick Paleozoic limestones. The inner foothills are more rugged than the outer foothills. Both are underlain by sedimentary rocks of various ages, arranged in northwesterly running ridges called fault thrusts.

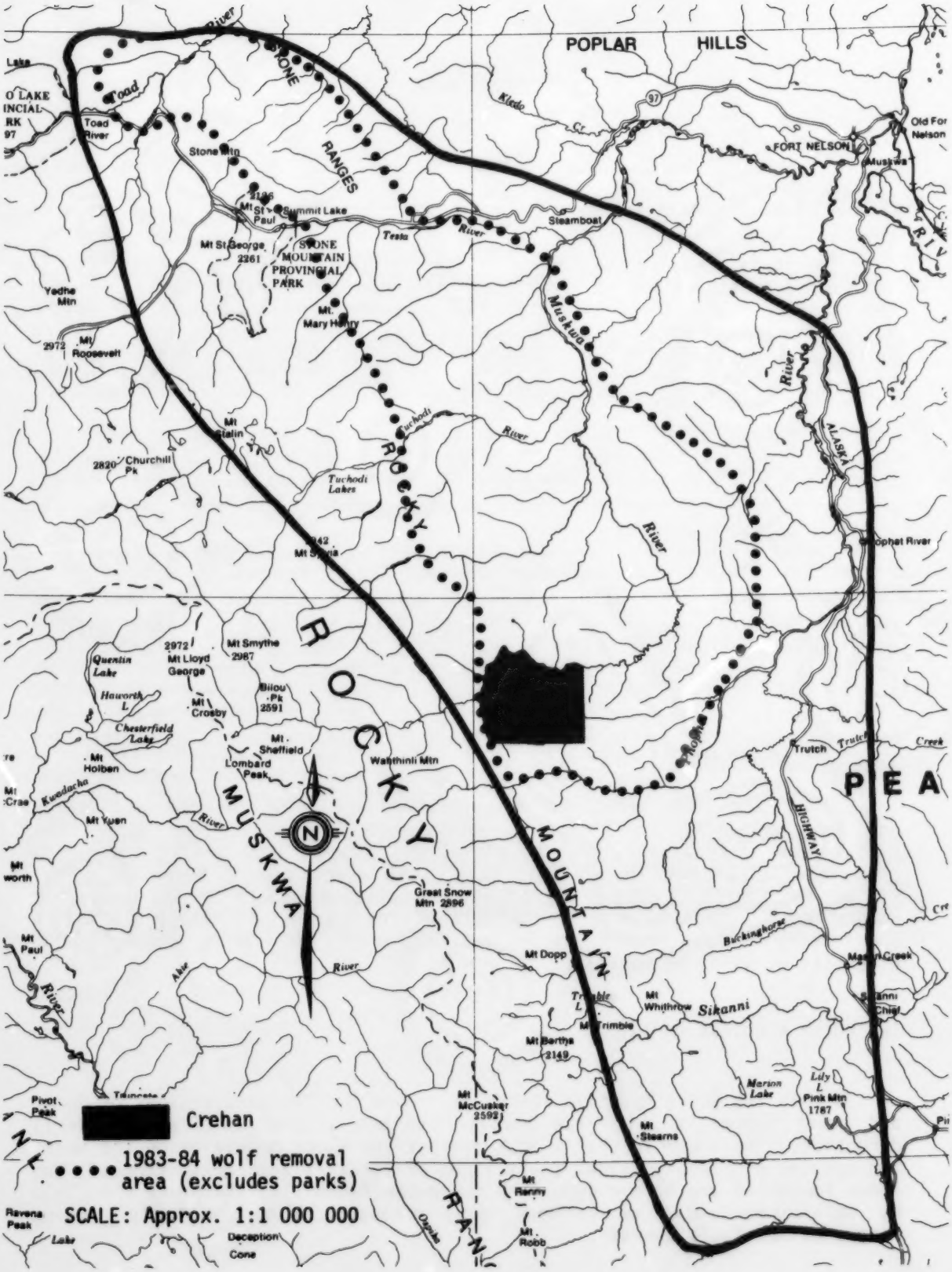

FIGURE 3: Muskwa study area

The large west-to-east running valleys originate in the Rocky Mountains, and continue through the Foothill Zone throughout the more erodible fault zones and softer shales. The floors of the valleys are deeply drift-filled, and range from 760 m to 910 m in elevation. The valleys are wide and are "U" shaped, with the north-south running ridges becoming increasingly subdued in elevation and relief from west to east. Elevations of the ridges average about 1500 m. With increasing elevation, the vegetation of the valleys progresses from the Boreal White and Black Spruce Zone to the Spruce-Willow-Birch Zone, and the Alpine Tundra Zones (Krajina 1965). The deeply incised valleys of Kluachesi Creek, Gathto Creek, Dead Dog Creek, Tuchodi River, Falk Creek, and others present optimal wildlife habitat in a variety of successional stages due to their aspects, elevation, soil developments, and climate. Reflecting the high wildlife values of the area, an extensive history of prescribed fire to encourage early successional vegetation is apparent throughout. Much of this dates back to very early times, however horse range improvements by an active Guide-Outfitting industry in the area have had a significant effect.

THE MUSKWA/PROPHET CUESTA

East of the Rocky Mountain Foothills between the Muskwa and Prophet Rivers, there is a distinct cuesta formed by the gentle folding of the Sikanni Sandstone Formation. The cuesta slopes gently east, to the Prophet River, with an abrupt scarp dropping from 1500 m to the Muskwa River valley, at about 750 m elevation on the west. Elevations range from 1500 m on the west to 600 m on the east. The southern edge of the cuesta has a scarp which drops steeply down to the Fort Nelson Lowlands. The vegetative characteristics are rather similar to the foothills to the west, and the many deeply incised valleys such as Tenaka Creek, the Akue River, and Seeds Creek offer diverse and productive wildlife habitats encompassing the Boreal White and Black Spruce, the Spruce-Willow-Birch, and the Alpine Tundra Biogeoclimatic Zones (Krajina 1965). Fire history has been irregular in this area. In recent years, there have been only a few wildfires creating optimal successional stages for wildlife in recent years.

THE FORT NELSON LOWLANDS

This zone includes the Prophet River valley and the large, poorly drained flats south of the cuesta, between the Prophet and Muskwa Rivers. The area is largely a Black Spruce-Willow-Birch association, with limited better drained areas supporting white spruce, lodgepole pine, or aspen depending on local fire history and soil conditions. Elevations are below 610 m (Holland 1964).

CLIMATE

Characteristic of the boreal forest are the long, harsh winters and cool, moist summers. Precipitation averages about 45 cm, with 50% to 60% occurring during the summer months as rain (Figure 4; Tables 10, 11, and 12). This pattern results from cyclonic storms from the Gulf of Alaska which bring heavy, short-term showers. During the winter months, weather is dominated by polar air masses centred over the Northwest Territories. Total snowfall averages about 192 cm, but varies depending on elevation, slope, and aspect.

Figure 4 presents a summary climate diagram for the area using the 30-year weather records from Fort Nelson. Weather data for the foothills and mountain portions of the study area are generally lacking, and are highly variable.

Temperature inversions and strong, frequent chinook winds make the foothills and mountains more attractive to wildlife due to snow removal and energy advantages. There is also a significant snow shadow effect from the high Muskwa Ranges to the west. Temperature extremes range from -59 C during January to 33 C in June, and mean daily temperatures range from 9 C to 3 C.

Solar radiation plays an important role in these harsh climates and many species such as sheep and elk utilize areas maximizing sunlight during the winter. Sunlight duration for the period October 15th to June 20th ranges from 6-to-20 hours per day.

PRESENT POPULATION STATUS AND PROBLEM IDENTIFICATION

Wolf densities in the study area are among the highest recorded in North America at 1 wolf/25 km (Figure 5,Table 13). Since 1977, the area has been surveyed four times, and has shown a rapid increase in wolf numbers with density increasing almost 4-fold between 1977 and 1984 (Table 13).

Moose recruitment in the Muskwa area has declined by approximately two-thirds since 1977 (Table 14). Using an adult mortality rate of 20% (in the presence of moderate wolf numbers), it follows that moose numbers have been declining at an accelerating rate for the past several years to a present 15% decline per year. It further follows from a comparison of Tables 13 and 14 that the declining calf proportions are closely correlated with wolf numbers. Indeed, 79% of the variation in recruitment between years is statistically explicable by the number of wolves (Elliott 1984).

Table 15 summarizes recent data for elk calf to cow proportions for a small area moderate wolf density portion of the Muskwa (the Crehan) and the regular high wolf density Muskwa. It is apparent that the herd status at high wolf numbers is substantially poorer than that at even moderate wolf numbers. Further, there is a strong correlation between juvenile proportions and wolf numbers. Indeed, 82% of the year-to-year variation in elk calf proportions is statistically explicable by the number of wolves (Elliott 1984). Using adult female elk mortality rates found for a moderate wolf

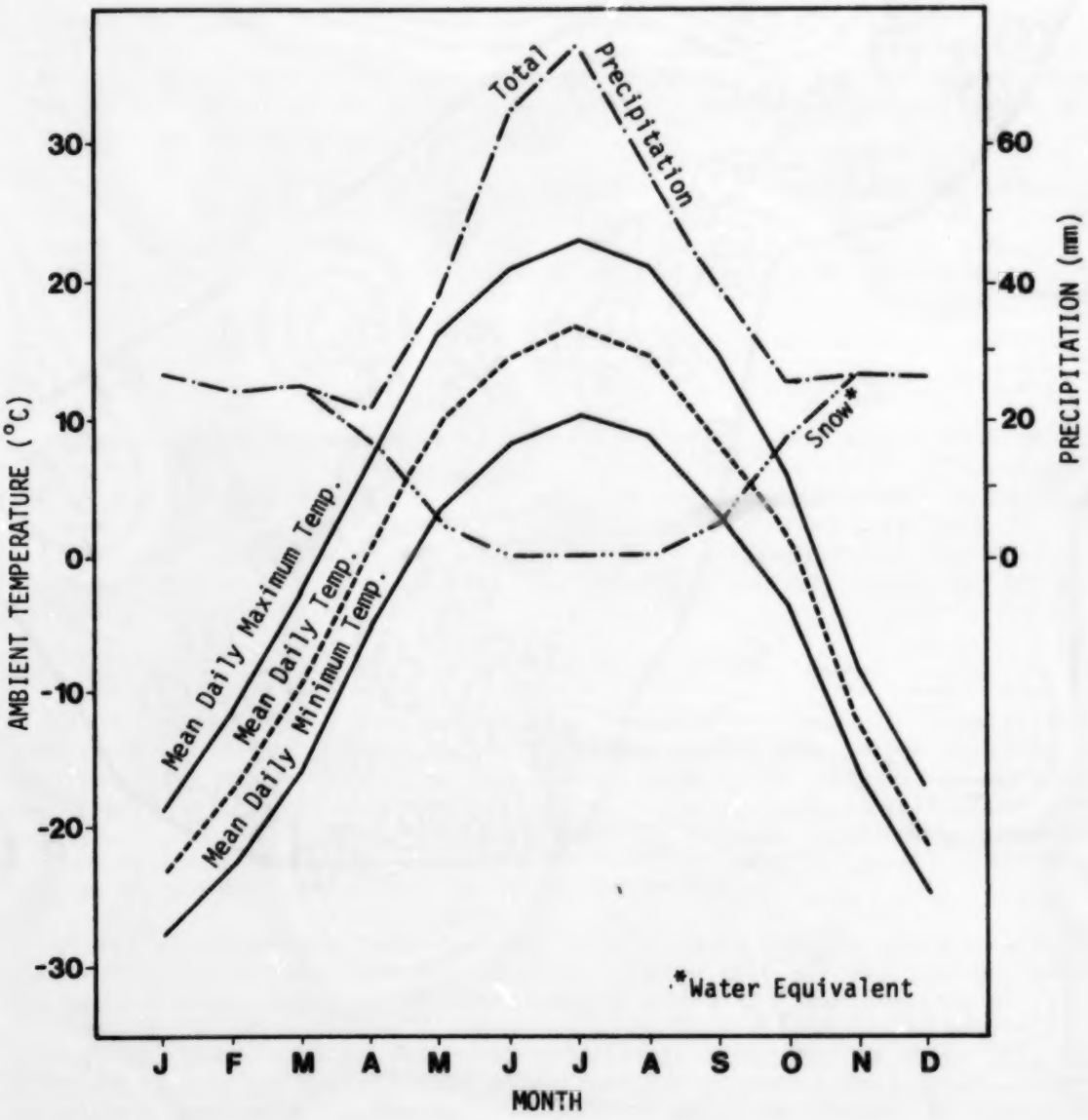

FIGURE 4: Climate diagram for Fort Nelson, based on 30 year mean values.

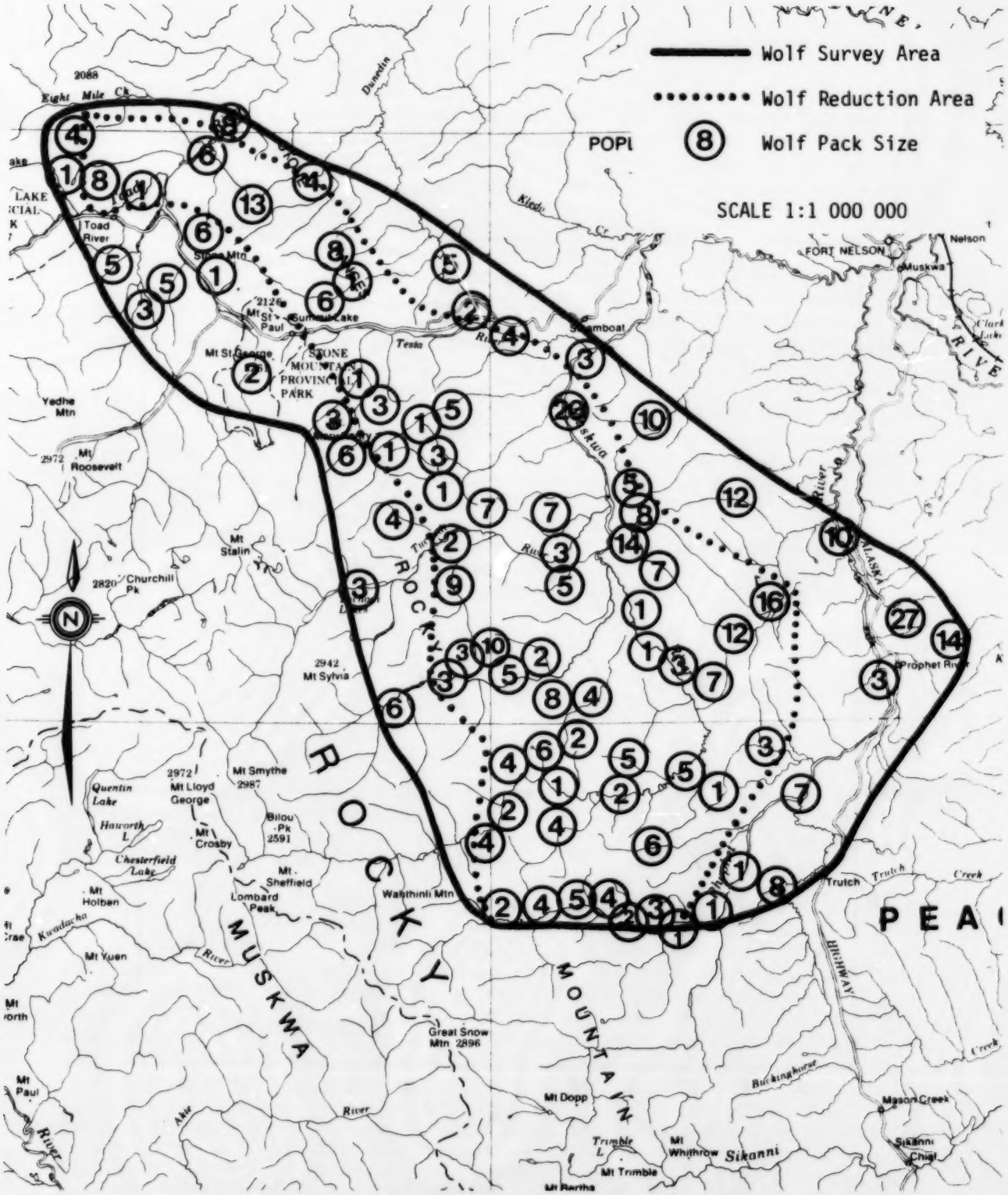

Fig. 5: Wolf Distribution - 1983-1984.

density in Jasper (Carbyn 1974) and comparing those to the input of late winter female juveniles, the cow elk herd is now declining at 8% per year.

Table 16 presents recent Stone's sheep juvenile to ewe proportions for the Muskwa plus wolf densities for the same years. It can be seen that first and second year survival have progressively deteriorated. Indeed, a comparison to adult ewe mortality rates from Kluane (Hoefs and Cowan 1979) indicate that the Stone's sheep ewe herd may be declining at over 18% per year. Further, the increasing decline is strongly correlated with wolf numbers. About 90% of the year-to-year variation in lamb proportions and 100% of the variation in yearling survival are statistically explicable by the number of wolves (Elliott 1984).

Caribou, at less than 3% of the available large mammal prey for wolves, are an anomaly in that the residual numbers (less than one-third of 1970 numbers (Bergerud 1978)) are now increasing somewhat. It may be that this species is now at such low levels that wolves no longer seek it as prey.

SUPPLY AND DEMAND

Supply and demand are not independent variables. Thus the non-essential (to survival) nature of viewing and hunting appear to result in measured demand changing in response to supply. For example, the number of caribou hunters (demand) in the Peace-Liard area is correlated closely (r=0.79) to the percent success of caribou hunters (supply) (Fig. 6). Thus the measure of caribou demand (Y) is related to the measure of caribou supply (X) by the following equation:

$$Y = 62.36 \times -447.6 \quad (r=0.79, N=15).$$

Real demand does not decline in response to reduced supply and participation underestimates demand. (Indeed during the period of caribou decline illustrated in Figure 6, overall population and hunter numbers increased). It follows then that increasing supply will increase participation. Total sales of general hunting licences is probably close to a true resident demand for animals with most of these purchasers wanting a minimum of one big game animal for table consumption.

Table 17 summarizes total hunting licence sales for the period 1976 to 1981 during which fees have been stable. During that six year period there has been a steady increase in participation with a six year increase of 25%. Further, it can be seen from a comparison with Table 2 that if the provincial objectives (which include the zonal objectives) were met, it would only be possible to provide one big game animal per two hunters. This would assume no animals available to non-resident hunters which is counter to Ministry

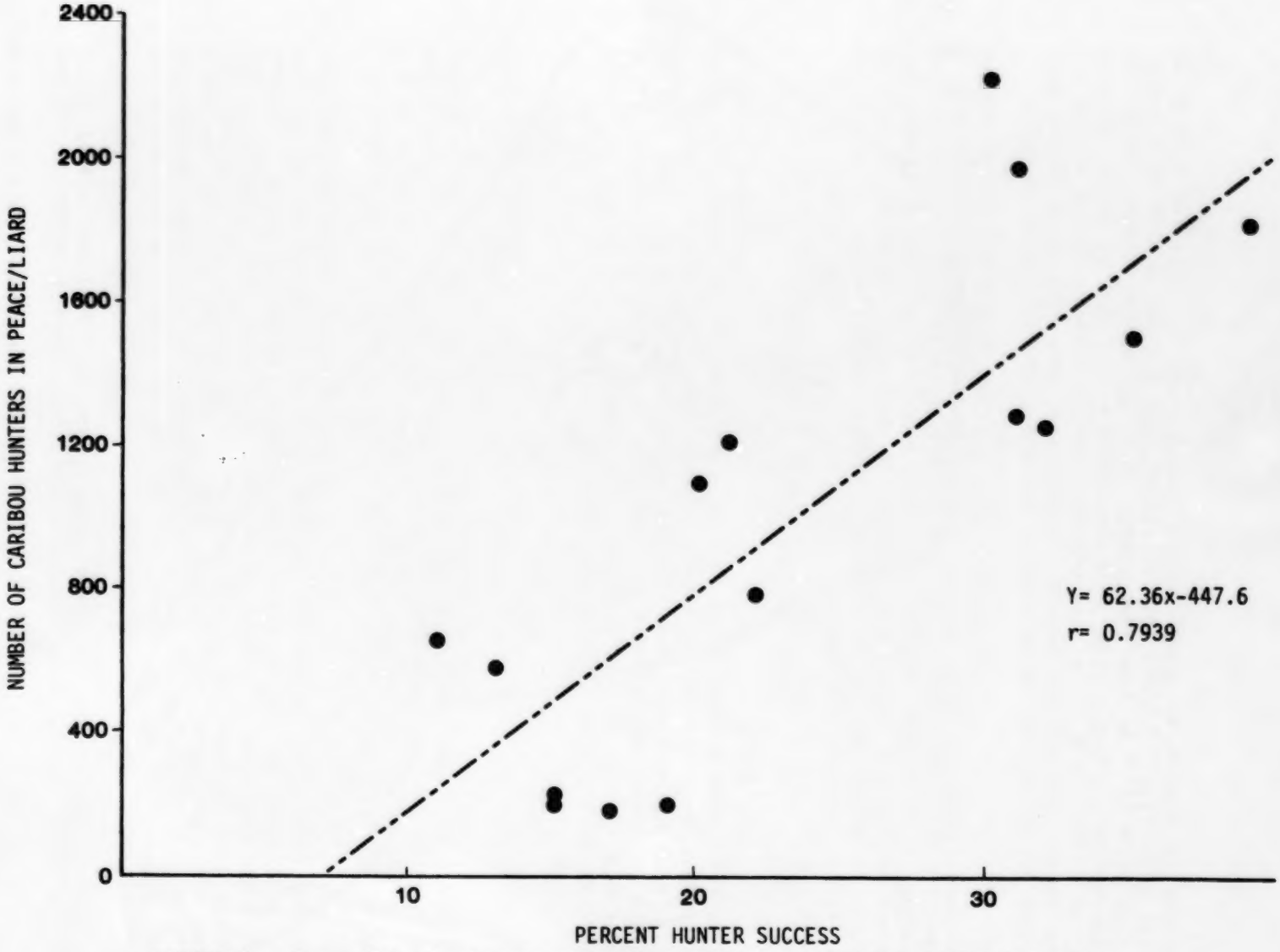

FIGURE 6: Peace /Liard subregional Caribou harvest by British Columbia resident hunters from 1967 to 1981 versus the number of Caribou hunters.

policy. It would seem, then, that demand is not a justification for delaying achievement of provincial and zonal objectives but, indeed, is a reason for the need to progress towards them.

A different measure of demand is provided by statistics on Limited Entry Hunters (L.E.H.'s). In 1982, the demand for limited entry hunts in British Columbia for the four species under consideration substantially exceeded supply (Table 18).

The sale of non-resident wolf licences and the estimated provincial wolf harvests support the view that wolves are not in high demand for hunting (Table 19).

It follows (from the Background section) that where natural mortality exceeds recruitment, the supply for public consumption is minimal or non-existent. Unless the supply is increased, the alternative is to hasten population declines as occurred for caribou in the early 1970's

STONE'S SHEEP

The zonal objective for Stone's sheep would allow a maximum annual harvest of 540 trophy animals or 72% of the provincial potential (Table 6). This is only 30% greater than the zonal harvest of the late 1960's and is less than one-third of the resident sheep tags sold in 1981. Indeed, while the number of resident sheep hunters in the province has doubled in the last six years, the sheep population in the northeast has halved. A large non-resident demand also exists.

ELK

The demand (as measured by participation) for elk in the northeast has been generally increasing (Figure 7) especially in the last eight years. Demand, however, already exceeds supply with 1981-83 showing a substantial decline in success and harvest.

MOOSE

The supply of moose, as measured by hunter-days per moose killed (Figure 6) has been declining both for the province and for the Peace-Liard. Interestingly, the Peace-Liard moose have not declined quite as severely as the province as a whole.

CARIBOU

The zonal objective (Table 6) for caribou would allow a maximum annual harvest of 300 animals per year. The annual zonal harvest in the late

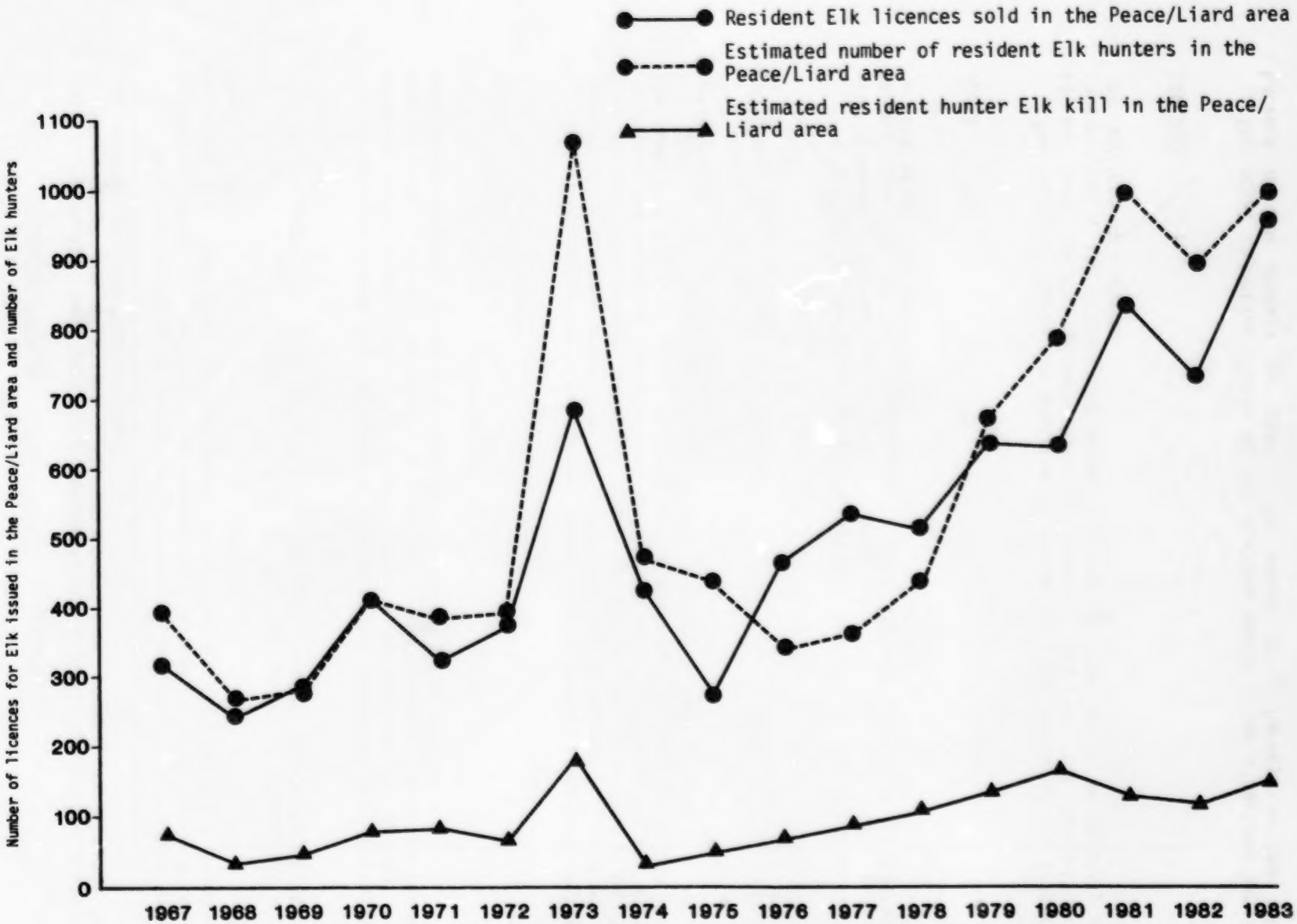

FIGURE 7: Resident Elk licences sold and estimated number of resident Elk hunters and their harvests within the Peace/Liard area for the period 1967 to 1983.

1960's and early 1970's considerably exceeded that number. This would clearly suggest that demand exceeds supply.

APPROACH: THE MANAGEMENT OF WOLVES

GENERAL

There appears to be an imbalance in wolf and ungulate prey numbers. There is some indication that this imbalance results from an historical increase in ungulate prey during twenty years of extensive and intensive wolf control in the 1950's and 1960's. After control was ended in 1967, wolves with a high reproductive rate increased to take advantage of an abundant food supply. They have exceeded the productive abilities of that prey, and are now rapidly depressing the ungulate prey populations. It is predicted that the wolf increase will slow and ultimately starvation will decrease wolf numbers. Ungulates have coexisted with wolves for thousands of years. It follows then that natural mechanisms exist which allow moose, elk, Stone's sheep, and caribou to survive at some level in the face of predation by wolves. However, totally natural areas are non-existent. Even a remote area such as the Muskwa has its share of roads, mines, oil wells, timber harvest, agriculture, and other developments. Secondly, escape of large ungulate prey from population control by wolves appears to be infrequent and short-lived in the absence of wolf control (Bergerud 1983; Keith 1983; Mech and Karns 1983; Gasaway et al. 1983). Thus high or even moderate densities of ungulates cannot be maintained for any extended period without some form of wolf reduction.

METHODS

Economic efficiency dictates that a wolf reduction area be of sufficient size that immigration of wolves into the area does not rapidly offset density reductions. Work elsewhere suggests that reduction areas should probably exceed 20 000 sq km (7720 mi) to meet this criterion (W. Gasaway, pers. comm. 1984). The Muskwa unit is too small from this standpoint, thus a wolf management area incorporating most of the Muskwa and Sikanni plus portions of the Trutch and Fort Nelson units will be adopted (Fig. 3). Annual budgets, exigencies of weather and other factors may necessitate a phasing-in of wolf reduction.

Monitoring of wolves and ungulate prey during the program is of paramount importance. Recruitment will be the key extensive indicator of ungulate population status. However, absolute population of representative areas for the main ungulate species will be determined both early and late in the program as a cross comparison to the annual recruitment estimates. Population estimates for wolves will be derived annually.

Wolf Inventory

Wolves are inventoried by a technique developed in Alaska (Stephenson 1978). Likely wolf travel routes are flown until fresh signs are encountered. The trail is then followed until either the wolves are spotted or the tracks separated sufficiently to enable a count. When necessary, track counts are confirmed by landing and examining the sign in detail from the ground.

Wolf Removal

Wolf removal is done by government personnel from a Bell 206 helicopter. Conventional shotguns loaded with SSG shot are used. Fixed wing spotter aircraft are utilized to direct the helicopter to locations of fresh wolf tracks.

Where feasible, wolf carcasses will be recovered and examined for age, sex, and any abnormalities.

Moose and Elk Surveys

Transects are flown in the autumn and late winter period each year to estimate the age and adult sex ratios of the moose and elk. Transects are uniformly spaced, straight lines (modified where necessary for feasibility in rough topography) and predetermined on 1:250 000 topographic maps. It is felt that this pattern would be random relative to the animals.

Moose are classified as to calf, yearling, and adult male, or adult female based upon shape, size, presence or absence of light vulval hair, head colouration, and antlers. Elk are classified as to calf, yearling male, 2+ male, or non-calf female based upon size, shape, and antler presence and configuration. Elk monitoring is confined to the winter range of the main herds found in the Muskwa, Kluachesi, Gathto, Tuchodi, and Chlotapecta drainages.

Stone's Sheep Surveys

Stone's sheep are inventoried in late winter from a Bell 206 helicopter. Complete units are searched through all sheep habitat types and at all elevations and aspects by flying contours. Speed and closeness were varied so that the observers were placed optimally according to visibility.

Animals are classified as to lamb, yearling, 2+ female, 2-year male and 3+ male based upon size and horn characteristics. Because of the wider distribution of males, it was felt that the survey method for smaller units is biased against males, however, ratios of juveniles to ewes are believed unbiased.

Caribou Surveys

Caribou are survyed in late October in the vicinity of the rutting benches between the Tuchodi and Tetsa Rivers. Bergerud (1978) refers to this as part of the Tuchodi River herd. These surveys were not intended to be complete counts but only unbiased samples. Animals were classified as to calf, non-calf cow, and non-calf bull. Sex differentiation was based on the presence or absence of the vulva.

ANALYSIS

The Muskwa project was evaluated following the principles set out in the provincial Guidelines for Benefit - Cost Analysis. The analysis took account of the costs of enhancement, predator control and monitoring from the inception of the project in 1981 through to the completion of the project in 1986 and estimated the expected increase in hunting made possible by the project. The results indicate a ratio of benefits to costs of 5.4:1 (Reid 1984).

Standard statistical procedures will be applied for sample analysis. Two types of comparisons are conventionally used for identifying treatment effects: comparisons over time and comparisons between areas. For the Muskwa project, comparisons will be primarily over time. However, anticipated ongoing monitoring elsewhere within the zone will provide useful area comparisons. Comparisons on moose and Stone's sheep will be made with the Jennings-Blue, Deer-Trout, and Finlay-Pelly areas where no wolf reduction will be conducted (Figure 1). Comparisons on caribou will be made with the Spatsizi and Level-Kawdy areas. If a statistically significant improvement in ungulate status cannot be demonstrated after three years of wolf reduction, the project will be discontinued. If the data show that there has been an improvement in ungulate populations, the program will be re-evaluated to determine if it should be continued or modified.

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Table 1. Provincial priorities by species.
(Muskwa sub-unit priority species underlined)

Species	Priority
endangered or threatened	1
moose, elk, deer, caribou	2
mountain sheep, mountain goat, bears	3
raptors, wolf, cougar	4
waterfowl, furbearers, upland game birds	5
non-game birds, and mammals, reptiles, amphibians	6

Table 2. Provincial objectives for priority 1, 2, and 3 species.and the wolf (Priority 4).

Species	Objective (Annual)
Endangered or threatened	prevent extinction
moose	300 000 animals, harvest of (30 000)
deer	475 000 animals, harvest of (60 000)
elk	22 000 animals, harvest of (3000)
caribou	20 000 animals, harvest of (1000)
mountain sheep	16 000 animals, harvest of (450)
mountain goat	50 000 animals, harvest of (1500)
grizzly bear	5000 animals, harvest of (250)
black bear	40 000-90 000 animals,harvest of(4000)
wolf	maintain wolves in balance with prey

Table 3. Subunits of the northeast zone.

Subunit	Size (sq km)
Deadwood	7000
Kechika	15 000
Liard	12 500
Rabbit	8000
Toad	8000
Crest	6000
Muskwa	14 000
Fort Nelson	14 500
Etsho	39 000
Trutch	7000
Sikanni	6500
	137 500

Table 4. Northeast zone wildlife species priorities.

Priority	(Muskwa project priority species underlined)
1	elk, mountain sheep, moose
2	caribou, mountain goat, grizzly bear
3	furbearers
4	endangered and threatened*
5	deer, wolf upland game birds, black bears, waterfowl, raptors
6	non-game birds and mammals, reptiles, amphibians

* The Anatum peregrine falcon is the only known threatened species to occur in the zone and its management is being effected largely at the provincial level; there are no known endangered species in this zone.

Table 5. 1982 population estimates for elk, mountain sheep, moose, and caribou in the northeast zone.

Subunit	Elk	Mt. Sheep	Moose	Caribou	Wolf
Deadwood	--	300	2000	500	
Kechika	50	2000	10 000	150	500
Liard	50	50	4000	300	
Rabbit	--	300	3000	150	
Toad	50	500	2000	250	
Crest	--	200	1000	100	
Muskwa	4000	3000	12 000	500	465
Fort Nelson	50	50	3000	75	
Etsho	--	--	4000	75	
Trutch	50	50	3000	--	
Sikanni	300	750	6000	450	
	4550	7200	50 000	2650	

Table 6. Northeast zone objectives for elk, mountain sheep, moose and caribou.

Subunit	Elk	Mt. Sheep	Moose	Caribou
Deadwood	100	500	4000	1000
Kechika	10 000	6000	16 000	500
Liard	400	100	10 000	500
Rabbit	100	900	6000	1000
Toad	200	1300	4000	500
Crest	---	500	2000	250
Muskwa	12 000	6000	20 000	1000
Fort Nelson	100	100	9000	100
Etsho	---	---	8000	150
Trutch	400	100	7000	---
Sikanni	1700	2500	14 000	2000
	25 000	18 000	100 000	6000

Table 7. Subunit potential percent contribution to meet zonal objectives for elk, mountain sheep, moose and caribou.

Subunit	Elk	Mt. Sheep	Moose	Caribou
Deadwood	1	3	4	14
Kechika	40	33	16	7
Liard	2	1	10	7
Rabbit	1	5	6	14
Toad	1	7	4	7
Crest	-	3	2	4
Muskwa	48	33	20	14
Fort Nelson	1	1	9	1
Etsho	-	-	8	2
Trutch	2	1	7	-
Sikanni	7	14	14	28

Table 8. Rating of subunit potential contribution to meet zonal objectives for elk, moose, mountain sheep, and caribou.

Subunit	Rating[1]			
	Elk	Mt. Sheep	Moose	Caribou
Deadwood	14	43	57	200
Kechika	267	220	107	46
Liard	16	8	80	56
Rabbit	12	62	75	176
Toad	12	87	50	88
Crest	--	50	33	70
Muskwa	343	236	143	100
Fort Nelson	7	7	62	7
Etsho	--	--	21	8
Trutch	29	14	100	--
Sikanni	108	215	215	431

[1] see text

Table 9. Weighted rating[1] and ranking of subunit potential contribution to meeting zonal objectives.

Subunit	Weighted Species Rating				Overall Rating	Rank[2]
	Elk	Mt. Sheep	Moose	Caribou		
Deadwood	14	43	29	50	136	3
Kechika	267	220	54	11	552	2
Liard	16	8	40	14	78	4
Rabbit	12	62	38	44	156	3
Toad	12	87	25	22	146	3
Crest	--	50	17	18	85	4
Muskwa	343	236	72	25	676	1
Fort Nelson	7	7	31	2	47	5
Etsho	-	-	21	2	23	5
Trutch	29	14	50	-	-	4
Sikanni	108	215	108	108	539	2

[1] see text

[2] grouped

Table 10. Mean total precipitation summary for the months January to June from Fort Nelson and Muncho Lake.

Location	Total precipitation (mm)						Number of years of record
	January	February	March	April	May	June	
Fort Nelson	26	24	25	22	38	64	30
Muncho Lake	41	36	17	8	42	50	9

Table 11. Snow depths at Fort Nelson and Summit Lake for the months January to June.

Location	Snow depths (cm)						Number of years of record
	January	February	March	April	May	June	
Fort Nelson	33	47	52	49	4	0.0	15
Summit Lake	NA	39	46	49	15	0.0	1

Table 12. Mean temperatures from weather recording stations at Fort Nelson and Muncho Lake from January to June.

Location	Mean monthly temperature (C)						Number of years of record
	January	February	March	April	May	June	
Fort Nelson	-23	-17	-9	1	10	15	30
Muncho Lake	-13	-18	-3	1	6	11	4

Table 13. Estimated wolf densities in the Muskwa area, from 1977-84, based on late winter aerial surveys.

Year	Area searched (km^2)	Sq Mi/Wolf	Sq Km/Wolf
1977-78	10,800	36	94
1981-82	7,300	25	65
1982-83	12,000	13	35
1983-84	12,000	10	25

Table 14. Estimated proportion of moose calves in the Muskwa area from 1977-84, based on late winter aerial surveys.

Year	Percent Moose Calves	Sample size
1977-78	15.2	211
1981-82	16.5	328
1982-83	6.9	303
1983-84	5.7	333

Table 15. Recent historical elk calf proportions and wolf numbers in the Muskwa area, late winter surveys.

Year	Area	Calves/100 (cows[1])	Sample size	Sq km/Wolf
1981-82	Muskwa[2]	20.9	1300	65.0
1982-83	Muskwa	13.8	381	34.7
1982-83	Crehan	26.0	187	129.5
1983-84	Muskwa[2]	14.0	1044	25.4
1983-84	Crehan	18.0	153	90.6

[1] cows are > 2 years old

[2] excluding Crehan

Table 16. Mountain sheep and wolf densities for the Muskwa area from 1980-84, based on late winter surveys.

Year	Lambs per 100 ewes(2+)	Yearlings per 100 ewes (2+)	Yearlings/100 Lambs the previous year	Sample Size	Sq km/ wolf
1980-81	40.2	27.3		288	72.5
1981-82	36.8	25.0	62.2	199	65.0
1982-83	30.2	7.0	19.0	431	34.7
1983-84	21.2	3.5	11.6	430	25.4

Table 17. General hunting licence sales to British Columbia resident hunters.

Year	Number of Licences Sold
1976	139 489
1977	144 447
1978	155 605
1979	163 088
1980	167 879
1981	174 088

Table 18. Demand/supply ratios determined from 1982 limited entry hunting.

Species	Number of Permits Available	Number of Applicants	Demand/Supply
mountain sheep	165	1666	10.1
elk	3849	12 765	3.3
moose	4578	14 100	3.1
caribou	89	406	4.6

Table 19. Non-resident wolf species licence sales and estimated harvests, 1976 - 1983.

Year	Number of Non-res. licences	Est. Res.[1] Harvest	Est. Non-res.[2] Harvest	Total Harvest
1976	296	660	37	697
1977	373	149	39	188
1978	433	487	39	526
1979	511	426	38	464
1980	564	378	32	410
1981	521	173	32	205
1982	418	293	40	333
1983	375	740	22	762

1 based on deer hunter questionnaire not considered reliable because of small sample.

2 from guided hunter reports.

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Wildlife working reports should not be cited because of the preliminary nature of the data contained within.

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